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# IN FTAL

*Resources  
for  
Development*

**UNIVERSITY OF HAWAII  
COLLEGE OF TROPICAL AGRICULTURE  
AND HUMAN RESOURCES**

**UNITED STATES AGENCY  
FOR INTERNATIONAL DEVELOPMENT**

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**PREFACE**

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NifTAL is an international development support program in tropical agriculture operating from the University of Hawaii.

Many development agencies, along with governmental and private volunteer organizations already tap the resources offered through NifTAL.

This pamphlet aims to bring NifTAL resources to the attention of an even wider audience.

We describe the areas under which services are offered, highlight the specific nature of the assistance, and provide concrete examples of how these services have been used.

Be assured that your inquiries about NifTAL are welcome and will be handled responsively.

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**NIFTAL BACKGROUND**

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In 1975, the United States Agency for International Development (USAID) contracted with the University of Hawaii to implement a project to help farmers in the developing countries step up production of high protein foods with reduced dependence on costly nitrogen fertilizers. This is being accomplished by ensuring that nitrogen fixed biologically by legumes is maximized and used to the fullest extent possible in tropical cropping systems.

The initial USAID contract drew on expertise in the College of Tropical Agriculture and Human Resources for establishment of an interdisciplinary unit called NifTAL<sup>®</sup>, dedicated to the application of technologies based on biological nitrogen fixation (BNF) to international development goals.

NifTAL's early years were spent building a resource capability in Hawaii to service the needs of national programs of the developing countries for research support, information and technical services, and multitier training.

In 1979, NifTAL undertook to facilitate global, regional, and in-country networks to enable developing country scientists to gather multilocation data needed to answer key research questions. These networks have been effective in providing developing countries with access not only to the resource represented in NifTAL, but also to expertise of leading BNF scientists throughout the U.S., Europe, and Australia.

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## NIFTAL BACKGROUND

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And because BNF scientists in neighboring countries recognized advantages in sharing their perspectives on how to apply their acquired expertise to crop production constraints, tighter networks have emerged.

Recently, in-country networks have been forming to put in place the infrastructure needed to support the use of BNF technologies by farmers. These networks typically involve several government departments, nongovernmental organizations, private entrepreneurs, and aid agencies.

It has been a privilege for NIFTAL to participate in this progression towards fuller use of biologically fixed nitrogen in tropical cropping systems. In meeting the challenge to tackle remaining constraints, we rely increasingly heavily on collaborative linkages with colleagues in the developing countries and elsewhere within the framework of a global BNF network.

\* NIFTAL is an acronym from Nitrogen Fixation by Tropical Agricultural Legumes.

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## CURRENT TRENDS AT NIFTAL

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The 1983 reporting year saw NIFTAL tackling a new contract with a wider scope of work, adjusting to shifts of emphasis in research and training, and establishing a BNF Resource Center for South and Southeast Asia at Bangkok.

Wider Scope of Work. NIFTAL's goal remains unchanged: to enable farmers in developing countries to increase production of high protein crops with reduced dependence on nitrogen fertilizer. NIFTAL addresses this challenge through programs to maximize the benefits of biological nitrogen fixation (BNF) in tropical cropping systems. At one time NIFTAL dealt exclusively with tropical grain legumes which have a direct role in human nutrition. Later, the tropical forage legumes were included. Given the important non-food uses of legumes, especially the tree species, NIFTAL is now mandated to address BNF aspects of all legumes with a role in development. This expansion is consistent with NIFTAL's role as a flexible and responsive unit offering development support in a key process (BNF), rather than a specific discipline or commodity. Thus, NIFTAL balances and complements the legume programs of the International Agricultural Research Centers and Collaborative Research Support Programs which focus on particular commodities and defined geographic areas.

Shift in Research Emphasis. In the past, NIFTAL has concentrated on selection of superior strains of Rhizobium for use in inoculants for tropical legumes in harsh soil

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## CURRENT TRENDS AT NIFTAL

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conditions. Although further advances with this approach can still be expected, satisfactory strains have been assembled for many legumes and for most soil conditions. Now it is time to develop an improved understanding of how to manage tropical cropping systems to optimize use of nitrogen fixed biologically.

**New Training Goals.** Since 1975, we have trained many key researchers through our postgraduate programs and short courses. In some countries, the technology is now in demand by farmers and by industrialists interested in legume inoculants. Thus, NIFTAL is now working with extension leaders design of materials to explain the use of BNF technology to farmers. We are also delivering training on commercial scale production of quality inoculants.

**BNF Resource Center.** National agricultural organizations of the developing countries have research programs on leguminous crops. Even when the approach is multidisciplinary, few legume teams can include professional Rhizobium specialists. A philosophy implicit in the NIFTAL concept was assembly of a relatively large resource unit in Hawaii, staffed by BNF specialists with a commitment to international development and equipped to service the needs of national legume programs. It is becoming increasingly difficult and costly to meet requests for specific support to national programs from our Hawaii base. NIFTAL is taking an initiative to offer research support, technical and material services, and training oriented specifically at production

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**CURRENT TRENDS AT NIFTAL**

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constraints of the cropping systems of the South and Southeast Asian region. We are indebted to the Thailand Department of Agriculture for hosting the BNF Resource Center and for providing superlative facilities. Through this presence in the region, we expect to capitalize even further on the network approach to accomplishing research and facilitating the interchange of technical information.

These were the themes that dominated our most recent reporting year at NifTAL, and within this framework we are pleased to be recording real progress and positive achievement.

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## AN INTRODUCTION TO NifTAL SERVICES

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The focus of the NifTAL Project is a process (biological nitrogen fixation) rather than a commodity or a discipline. NifTAL rallies the expertise of many disciplines to address a process which benefits many commodities.

Some constraints on fuller utilization of biological nitrogen fixation are technical and are being addressed through research. Economic and social factors also limit this technology as does lack of personnel trained in the skills required for research, development and use of inoculants.

Although the focus seems narrow, a wide range of activities is undertaken by NifTAL to ensure that the process is used to the maximum extent in tropical cropping systems:

- Regionalization of BNF support
- Training and communication
- Country and interagency projects
- International network trials
- Legume inoculant development
- Rhizobial germplasm development
- Rhizobial antisera services
- N management in cropping systems
- Soil stress tolerance research
- Economic analysis of BNF

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**REGIONALIZATION OF BNF SUPPORT**

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**OBJECTIVE**

-- to tailor development support services offered globally from NifTAL, Hawaii to specific needs of countries of South and Southeast Asia.

**BACKGROUND**

Many general resources for development assembled during NifTAL's early years remain widely applicable throughout the tropics. But as the emphasis at NifTAL has progressed from legume inoculation into the strategic use of legumes in tropical cropping systems, it has become necessary to tailor NifTAL outputs to the vastly differing cropping practices of the world's major geographic regions and the contrasting degree of advancement of agriculture in specific countries.

NifTAL hopes to contribute ultimately to establishment of a comprehensive BNF capability in the national agencies of each developing country. Establishment of regional BNF Resource Centers is viewed as an interim step towards that goal.

This step also makes it easier for USAID's Regional Bureaus and Country Missions to tap NifTAL resources in support of regional and country programs involving legume crops.

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## **BNF RESOURCE CENTER AT BANGKOK**

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Bangkok was considered the most appropriate location for the Center, because of Thailand's pivotal position in the region and a longstanding tradition of cooperation between the University of Hawaii NifTAL Project and the Soil Science Division of the Thailand Department of Agriculture. The Department of Agriculture endorsed the BNF Resource concept and, under a May 1983 Agreement, offered to host the Center at the Rhizobium Building, Bangkok, Bangkok.

In Oct 1983, a planning workshop was held in Bangkok to derive a workplan for the BNF Resource Center. Country representatives detailed the most pressing research and promotional needs to put BNF to work in their farmers' fields.

### **BNF RESOURCE CENTER SERVICES**

Virtually every service currently offered from NifTAL, Hawaii is now accessible at, or through the BNF Resource Center. Requests for services from countries in the region should be directed to Bangkok.

### **AN EXAMPLE OF A BNF RESOURCE CENTER SERVICE**

The Bangladesh Agricultural Research Council (BARC) requested assistance in design and implementation of a national workshop for Extension leaders on use of legume inoculants. The workshop was mounted in Bangladesh in March 1984, funded by BARC. A request for a follow-up course on the same basis has now been requested.

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**TRAINING AND COMMUNICATION SERVICES**

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**OBJECTIVE**

-- to disseminate NifTAL research output, and transfer professional skills and technical information for research, extension, and production enterprises required to assess and use of technologies based on biological nitrogen fixation for crop production in the tropics.

**TRAINING AND COMMUNICATION SERVICES**

- documents and information
- multitier training
- training materials
- visiting scientist programs
- workshop design

**EXAMPLES OF SERVICE RECORD FOR 1983**

During 1983 there were 378 requests for documents authored by NifTAL staff, and 225 copies of the proceedings of a NifTAL/CIAT/ICRISAT workshop on BNF Technology for Tropical Agriculture were distributed.

Past and current technical information on legume nitrogen fixation is available to researchers in developing countries through the NifTAL Document Collection.

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## TRAINING AND COMMUNICATION SERVICES

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The document collection now has 7,000 entries, of which just over 1,000 were added in 1983. Two bibliographies (1978 and 1981) and a periodic bibliography (inserted in the BNF Bulletin) detail the documents available. During 1983, NifTAL serviced 748 requests for documents from researchers in 44 countries.

NifTAL's BNF Bulletin sustains awareness by a broad international development audience of projects in progress worldwide that impact on the use of biologically fixed nitrogen in agriculture. The Bulletin is also a vehicle for exchange of ideas between researchers and decision makers. Over 1,600 readers in 100 countries receive three issues of the Bulletin annually.

NifTAL continues to target training at professionals and technicians. Now the need to train extension leaders and inoculant producers is also being addressed.

Training opportunities for professionals include graduate assistantships to pursue the PhD degree, and short-term internships at NifTAL headquarters covering advanced techniques for applied research.

Junior researchers and technical personnel can apply for intensive, practical short-courses offered by NifTAL in conjunction with host institutes in tropical countries.

Currently, graduate students working in NifTAL's program are from Bangladesh, Nepal, India (2), Zambia, Liberia, Japan, and the U.S.A. Scientists from Burma, India, Kenya, Mali, and the Sudan undertook internships with NifTAL in 1983.

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**NIFTAL SHORT---COURSES IN 1983**

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**LEGUME INOCULANT TRAINING COURSE**

-- mounted in India in cooperation with ICRISAT and FAO/UNEP, and offered to participants from India (9), Sudan (2), Egypt (1), and Indonesia (1).

**SYMBIOTIC N<sub>2</sub> FIXATION AND LEGUME INOCULATION**

-- mounted in Thailand in cooperation with the department of Agriculture, Thailand and North Carolina State University, and offered to 45 Thai research and extension managers.

**SYMBIOTIC N<sub>2</sub> FIXATION IN TROPICAL LEGUMES**

-- mounted in Costa Rica in cooperation with University of Costa Rica/CONICYT and offered to participants from Argentina (1), Bolivia (1), Brazil (1), Costa Rica (6), Colombia (1), Dominican Republic (1), Ecuador (1), Mexico (3), Peru (1), and Puerto Rico (1). Other international agencies cooperating were: Unesco, UNEP, ICRO, and IITA.

**ASSESSMENT OF AZOLLA IN LATIN AMERICA**

-- mounted in Peru in cooperation with the National Agricultural Research Institute of Peru, and offered to candidates from Peru (6), Uruguay (2), Brazil (1), Costa Rica (1), Colombia (2).

**AZOLLA ASSESSMENT WORKSHOP**

-- mounted in Senegal in cooperation with WARDA/ADRAU, and offered to 16 participants from African countries.

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## COUNTRY AND INTERAGENCY PROJECTS

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### OBJECTIVE

-- to apply the physical and human resources established at NIFTAL on USAID central funding to specific projects requested by USAID missions of individual countries, or by other development agencies. Such projects are integrated into NIFTAL's program, but are separately funded.

### MIRCEN PROJECT

NIFTAL is a designated Microbiological Resources Center (MIRCEN) committed to the preservation of agriculturally important microbial germplasm. A main value of this project to NIFTAL is that U.N. funding under the project supports participation in NIFTAL programs by nationals of countries not eligible for USAID assistance. This activity is conducted under the auspices of Unesco, UNEP, and ICRO with funds administered by Unesco.

### PACIFIC ISLAND WINGED BEAN PROJECT

There has been a recent upsurge in interest in the winged bean (Psophocarpus tetragonolobus) as a vegetable and fodder crop for small holder farmers in the Pacific Basin. NIFTAL is conducting experiments in Hawaii, Guam, and the Northern Marianas to develop appropriate rhizobial inoculants for winged bean varieties introduced to differing soil circumstances in the Pacific Islands. This project is funded by USDA CSRS.

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**COUNTRY AND INTERAGENCY PROJECTS**

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**INDO - U.S. SCIENCE AND TECHNOLOGY INITIATIVE**

NiftAL conducts a collaborative program with the Indian Agricultural Research Institute at Delhi and the University of Agricultural Science at Bangalore. The goals of the project are to establish a National Rhizobium culture collection, to improve legume inoculant quality, and select superior rhizobia for pigeon pea (Cajanus cajan). The project is supported jointly by the Indian and U.S. governments with U.S. funding administered by the National Science Foundation.

**ZAMARE PROJECT**

NiftAL participates with University of Illinois at Urbana-Champaign, University of Southern Illinois at Carbondale, and University of Maryland-Eastern Shore in a USAID/Zambia project to support Zambian agricultural research and extension. NiftAL has stationed a soil microbiologist with the Ministry of Agriculture at Mt. Makulu. He is responsible for research on soil microbiology in support of the soybean improvement program. NiftAL's staff member in Zambia is backed by technical assistance from NiftAL's Hawaii staff in legume inoculant production and extension guidelines on inoculant use. NiftAL is also training a specialist in biological nitrogen fixation methods through an M.S. program at the University of Hawaii. Accomplishments to date include establishment of a national Rhizobium culture collection and testing native strains for nitrogen fixation effectiveness with soybeans. The program is funded by USAID/Zambia.

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## COUNTRY AND INTERAGENCY PROJECTS

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### LEUCAENA SEED PRODUCTION

Demand for seed of the fast-growing, multipurpose tree "leucaena" has led to distribution of some lines of dubious purity and quality. NifTAL has established model seed production nurseries at several sites in Hawaii (and also in Costa Rica and Sierra Leone) to facilitate dissemination of pure lines of preferred leucaena germplasm. This project is funded by NAS through a Donner Foundation Grant.

### NITROGEN FIXING TREE GERmplasm

An integrated approach is being followed in this project to derive seed/rhizobia/mycorrhizae sets for nitrogen fixing trees with a potential role in development. Support is from the Science Adviser, USAID.

### OTHER PROJECTS

In addition to the funded projects already referred to, NifTAL is involved in many joint projects on a cost-shared basis. Organizations working with NifTAL in this mode in 1983 included: FAO, CIAT/UNDP, IADS, ICRISAT, BOSTID, and the Australian Development Assistance Bureau.

### FUTURE PROJECT OPPORTUNITIES

NifTAL remains responsive to requests from organizations with an interest in applying NifTAL resources to in-country needs that may be more specific than can be accommodated with in the framework of NifTAL's current general contract. Requests for participation by NifTAL staff in discussion and design of country projects are welcome.

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**INTERNATIONAL NETWORK  
OF LEGUME INOCULATION TRIALS**

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**OBJECTIVE**

-- to determine, under realistic field conditions, whether the yields of tropical legumes can be increased by inoculating them with selected strains of Rhizobium.

**SERVICES**

NIFTAL professionals travel regularly in service of researchers cooperating in the INLIT program. Such site visits are also an opportunity for national researchers to draw on the expertise of NiftAL professionals in aspects of agricultural research not directly relating to the INLIT program itself. Country visits also provide an opportunity for NiftAL staff to support USAID Missions.

Specific services offered through INLIT are:

- detailed field trial procedures
- improved rhizobial germplasm
- research grade inoculants
- data analysis
- national research program design assistance.

More than 200 scientists in the third world participate in the INLIT program. Over 300 trials have been analyzed and many of these confirm that inoculation increases yields.

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## LEGUME INOCULANT DEVELOPMENT

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### OBJECTIVE

-- to develop systems for improved inoculant delivery, and for ensuring dependable, effective inoculation in the field.

### BACKGROUND

NifTAL recognizes that the nature of present legume inoculants and the manner in which they are produced are constraining fuller use of the technology by farmers.

Many tropical countries do not have peat suitable for inoculant carrier, and in any case this form of inoculant is highly vulnerable to damage from high temperature exposure during distribution, storage and use.

Progress at NifTAL on improving the nature of inoculants has been primarily through development of inoculant strains which exhibit high temperature tolerance and satisfactory shelf storage without refrigeration.

### APPROPRIATE TECHNOLOGY

Conventional approaches to inoculant production appear overly sophisticated, risky, and highly capital intensive to entrepreneurs contemplating production in developing countries.

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**LEGUME INOCULANT DEVELOPMENT**

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Conceivably, if small-scale, simple, low-cost inoculant production systems were available, inoculants would be produced locally and seasonally, tied to farmer demand. Thus, the major risks to inoculant quality, namely transportation and storage, would be overcome, and the need to change the nature of inoculant would be alleviated. For this reason, NifTAL's main thrust to improve the quality of inoculant reaching farmers is development of small-scale, low cost production systems.

Previously we reported validation of a dilution approach to eliminating the need for large fermentors. Recent research confirms that the dilution procedure is acceptable using autoclaved peat as a carrier. A pilot version of a shaker-based production system has been designed and is operating with excellent results. The system is based as far as possible on materials readily available in developing countries rather than specialized items often used in U.S. laboratories, eg. avoidance of the use of low density polypropylene packages in favor of common polyethylene bags.

**SMALL - SCALE PRODUCTION UNITS**

Development of low cost fermentors of varying scales has been completed and these are being installed for operation at a remote facility without previous microbiological capability. This experience forces attention to detail, fine tuning the inoculant production technology packages on offer from NifTAL.

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## LEGUME INOCULANT DEVELOPMENT

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### EXTENSION MATERIALS

After due care is taken to ensure that quality inoculants reach farmers, much still depends on how cautiously the inoculant is handled and how competently it is applied. A pocket manual for extension personnel was therefore prepared giving background on legume inoculants and detailing in plain language how they should be used. FAO joined with NIFTAL in this venture and the pocket book will be available in 1984.

### INOCULANT DEVELOPMENT SERVICES

- technical assistance on inoculant production systems of differing capital cost.
- advisory services on strategies for inoculant manufacture, distribution, and quality control.

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**RHIZOBIAL GERMPLASM**

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**OBJECTIVE**

-- to maintain a Rhizobium germplasm resource comprised of authenticated, characterized rhizobial strains from a wide array of plant hosts and diverse geographic origins, from which to select strains which nodulate agriculturally important legumes under conditions prevailing in the tropics.

**GERMPLASM SERVICE**

- Catalogue of strains
- Rhizobium cultures
- Research grade inoculants
- Custom carrier supply
- Strain data interchange
- Custom data searches
- Nodule isolations
- Long-term repository
- Data base design assistance

Enquiries about services are welcome.

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## GERMPLASM SERVICE RECORD

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NifTAL serviced over 500 requests for cultures from scientists in 22 countries in 1983, double the 1982 level.

The NifTAL culture collection now has 1,774 strains of rhizobia. The strains were isolated from 285 different legume species and were collected in 56 countries.

A computerized, data base management system was designed for storage and retrieval of strain data, generating a strain catalogue, and handling the informational services offered to users. Data entry has been completed and a Catalogue of Strains is available.

NifTAL's research grade inoculants continue to be produced and are in demand around the world because: they are prepared using gamma-irradiated peat and present virtually no quarantine risk during international distribution; they contain sets of three or more antigenically distinct strains of rhizobia which can be followed in competition and persistence studies in soil; and they contain high numbers of well-characterized rhizobia.

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## **RHIZOBIAL ANTISERA**

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### **OBJECTIVE**

-- to establish a serum bank housing antisera for identifying the strains of Rhizobium recommended for the economically important legumes under test in the International Network of Legume Inoculation Trials (INLIT).

### **KEY ROLE OF ANTISERA**

The use of matched strains and antisera allows a researcher to distinguish introduced rhizobia from all others. This is an essential for proper interpretation of field data. Backed by NifTAL's serum bank, researchers can add a new dimension to field inoculation trials in the tropics.

### **ANTISERA SERVICES**

- antisera for agglutination
- antisera for gel immunodiffusion
- fluorescent antibodies
- antisera catalogue
- antisera methods manual
- custom antisera
- technical advisory services

Researchers in 13 countries requested 311 aliquots of antisera in 1983.

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## MANAGEMENT IN TROPICAL CROPPING SYSTEMS

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### OBJECTIVE

-- to derive an improved understanding of how to manage tropical cropping systems to optimize the benefits from nitrogen fixed biologically.

### SERVICES

This is a new undertaking by NifTAL and services at the present time are limited to the professional expertise of NifTAL staff, primarily in nitrogen cycling in agroforestry systems and legume-based, tropical pastures.

Shortly the proceedings of a NifTAL workshop to appraise the state of knowledge in this area will be available.

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**SOIL STRESS TOLERANCE**

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**OBJECTIVE**

-- to lower the cost of soil management, improve crop performance, and guide the choice of legumes for cropping systems by defining their tolerances to components of soil infertility.

**SOIL STRESS RESEARCH SERVICES**

- An array of defined test media and pH indicators for rapid, low cost screening of rhizobia for stress tolerance have been developed. These methods are suitable for laboratories with limited facilities and resources.
  
- Several experimental systems have been designed for split-root studies. This systems have purposely been improvised from readily available, low cost materials and may bring this valuable technique within the capability of researchers unable to use it previously.
  
- selected highly tolerant germplasm identified by the techniques referred to above is available.

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## ECONOMICS OF BIOLOGICAL NITROGEN FIXATION

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### OBJECTIVE

-- to devise and test appropriate methodology for measuring the economic benefits of the use of inoculated legume crops in farming systems of developing countries.

### SERVICES AVAILABLE

This is a relatively new NifTAL undertaking and at present services are limited to the following:

- a polyperiod mathematical programming farming systems simulation model, ready for testing and use in developing countries.
- a bibliography of publications on the economic aspects of the use of biologically fixed nitrogen in agriculture.

### FUTURE PLANS

The next phase of this activity involves an in-country study to test and appropriately modify the model to cope with parameters encountered in developing countries. A research assistant is being posted at Khon Kaen University, Thailand attached to the Farming Systems Project within the Faculty of Agriculture to accomplish on site research.

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**NIFTAL STAFF IN HAWAII**

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